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Noise risk assessment of the sensitive areas in the Administrative Center of Manolo Fortich Bukidnon

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Abstract

This study aims to record and assess the noise risk in the sensitive areas of the administrative center in the Municipality of Manolo Fortich, province of Bukidnon, Philippines. Since these areas are more exposed to the effects of noise pollution, there has been an increase in noise pollution which needs to be addressed. The study used quantitative research method through the collected noise data for each location using a SL-4010 sound level meter across three weeks. The study employed quantitative analysis in F-Test using SPSS. The noise data that are compared with the World Health Organization Standards indicates the occurrence of noise annoyance in the sensitive areas, which may hamper learning and focus on daily activities. The results show that there is a significant difference in the environmental noise levels across the different sensitive areas during the conduct of the data gathering. The noise level for the schools along the highway was higher than that of the tertiary institution located farther from the national highway. Furthermore, results suggest that there is no significant difference in noise levels across these sensitive areas both in the morning and in the afternoon with F-values, 72.05 and 84.93, respectively. The following interventions are recommended: (a) conduct noise monitoring, evaluation, and impact assessment; (b) implement strict urban planning and zoning regulations; (c) create noise barriers and buffer zones; (d) conduct public awareness and education collaboration; and (e) conduct of descriptive-correlational research. This study will serve as a baseline data for the local government unit that will lead to better ordinance, policies, and implementation process to control the noise annoyance in the sensitive areas. This study extends beyond the locality of the scope, for it may serve as a valuable resource information for battling noise pollution to create a better environment across the globe.

Keywords: *noise pollution, noise risk assessment, sensitive areas, environmental noise, environmental problems*

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1. Introduction

Everyday life is filled with noise. Prolonged exposure to daily unacceptable noise level may cause physical and mental illness. It is an important public health issue that significantly affects the people exposed to noise annoyance (Chan et al., 2024). High traffic areas produced most of the noise annoyance, these zones are often near the sensitive areas like schools and hospitals (Karki et al., 2024; Khaiwal et al., 2016). The noise produced by the motor vehicles with noisy engines contributes significantly to noise pollution which impacts the quality of life of the people around them (Estrella et al., 2024). There is an estimated 40% of the population exposed to a 55 dB or higher noise level both day and night. Hence, safety programs should be organized to educate the general public on the effects of noise pollution towards health (Sackey et al., 2024). Noise pollution has significantly contributed to the unfavorable living conditions found in urban and other developing areas. Some places such as schools, churches and healthcare facilities are areas where silence is an important attribute. Occupants in sensitive zone units, such as hospitals and schools, are now significantly impacted by noise pollution. Activities like migration to and from metropolitan areas and infrastructure construction have risen considerably in the sensitive zones. Noise is a significant contaminant in many urban populations worldwide (Aissa Mohamed, 2021).

Manolo Fortich was first inhabited by indigenous people who lived in harmony with nature and practiced subsistence farming. It was named after Manuel Fortich Sr., a heroic serviceman who fought during World War II. Manolo Fortich was incorporated as a Sumilao town neighborhood in 1950. Under Republic Act No. 6362, it was later formed as an autonomous municipality on August 20, 1971. It is located in the center of the Philippine Island of Mindanao's province of Bukidnon. Manolo Fortich is growing and is currently submitting an application to become a component city (LGU Manolo Fortich, 2022). As this humble municipality continues to welcome more commercial buildings and new industries, the risk of noise pollution has become imminent.

The study aims to record noise level data in the sensitive areas in the Administrative Center of Manolo Fortich as baseline information, the data were assessed based on World Health Organization (WHO) standards and the results were used as basis for sustainable intervention that will be recommended to the Local Government Unit. Specifically, this study seeks to determine the noise levels in the sensitive areas during morning and afternoon and

calculate any significant difference between the noise levels in the sensitive areas. The null hypotheses were tested at 0.05 levels of significance.

H_{01}: The noise levels in the sensitive areas are all compliant with the standard noise level recommended by WHO.

H_{02}: There is no significant difference between the noise levels in the sensitive areas in the morning and in the afternoon.

H_{03}: There is no significant difference in the weekly noise levels of the sensitive areas.

2. Literature review

Environmental noise is a severe issue that is becoming more prevalent; it influences human health and the environment. Despite the fact that extended exposure to noise produces often permanent physiological and psychological harm, noise sources are an everyday aspect of city life and have not yet received the attention they deserve (González-Gómez et al., 2020). Environmental noise management, also known as environmental noise control, entails various technical measures, such as lowering levels at the source, placing barriers outside between the source and receivers, and altering the acoustic characteristics of building envelopes to lower levels at the receivers. Hearing protection may also help lower receiver levels (Brown & Van Kamp, 2015). Although the frequency of a sound is relatively small, the human ear is always aware of its wide frequency. The weakest sound has a maximum frequency of 103 Hz and a displacement amplitude of roughly 10-9 cm. This perspective reveals that the human ear is a tremendously sensitive organ. Thus, the receiver might experience discomfort. Hearing loss can be caused by too much noise. A less than 15 dB set is necessary for this situation (Indrayani et al., 2020). Prolonged exposure above 85dB for more than 8 hours is dangerous, especially for individuals working near a busy road or highway (Karki et al., 2024).

A study conducted in the Municipality of Argao in Cebu showed that if the actual noise exposure level is compared to the students' perceived noise exposure, it is determined that they are at risk (Ellen et al., 2021). In a classroom setting, the issue of noise pollution has not received much attention. The leading causes of noise pollution in sensitive areas are traffic and the constant transit of school buses on the nearby roads. The average noise level of all the streets was 61.16 dB, indicating a significant problem with traffic noise pollution

(Lin-hua et al., 2013). Schoolyard noise levels should not be higher than LAeq 55 dB, whereas quiet classrooms should not be louder than LAeq 35 dB (Berglund et al., 1995). Researchers measured background noise levels in classrooms, finding that they typically exceed 35 dB (Bridget & Dockrell, 2004; Kamal et al., 2010). Planners must carefully craft school design, since younger children can be easily annoyed by noise compared to the older ones (Ali, 2013). It is obvious that noisy disturbances which exist in learning environments adversely impacts the cognitive abilities of students (Diaco, 2014).

There is an evidence that noise from traffic has an adverse effect on cardiac illness caused by ischemia, such as myocardial infarction. High blood pressure risk is increased by both airplane and traffic noise. People older than 64.5 years of age exposed to residential road traffic noise had a greater risk of stroke (Sørensen et al., 2011). Noise pollution can directly harm health by disrupting sleep and producing discomfort in addition to stress (Chan et al., 2024; Cohen et al., 2014; Jafari et al., 2019). When individuals reported being more annoyed by road traffic noise, there was a more significant correlation between the noise level and self-reported treatment of hypertension (Babisch et al., 2013). The WHO established a standard of 45 dBA as the ambient noise level for group learning in 2017, and this level is recognized as being quiet and ideal for learning. Noise levels above the WHO limit of 55 dBA are regarded as annoyance levels that make people feel annoyed and are therefore regarded as noise pollution, which will prevent them from engaging in their everyday activities (Zoleta & Sacabin, 2020). A sustained sound level of 85 dBA or above can damage hearing. The noise limit of 50 dBA was defined for educational spaces by the Brazilian Standard for Noise Assessment. Problems with motivation, memory, and attention are associated with performance levels that are above average (Kamal et al., 2010).

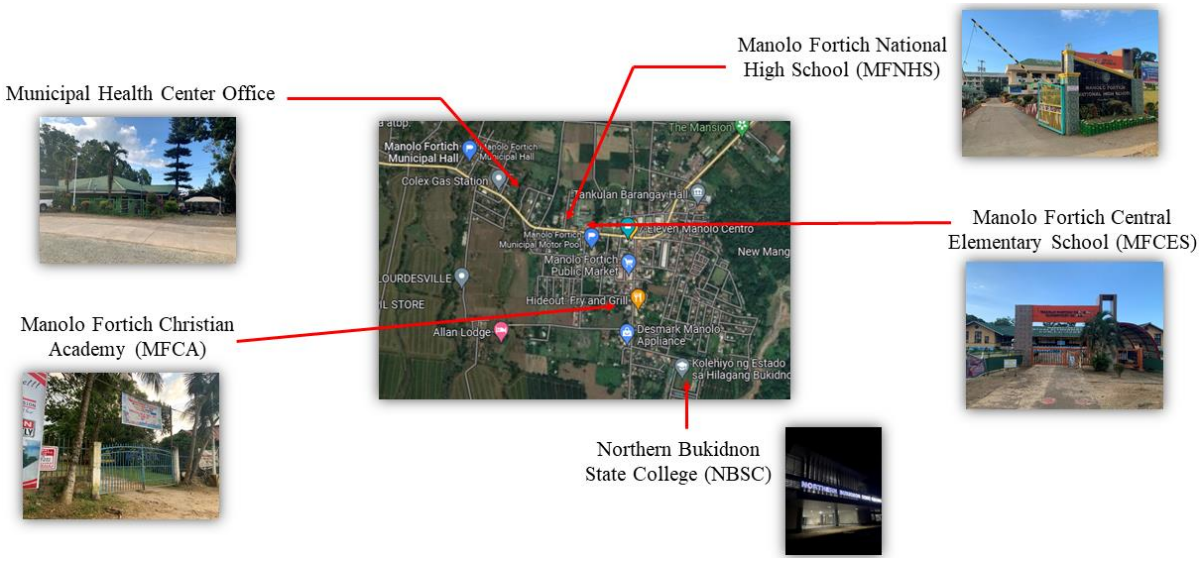
3. Methodology

This study is quantitative research that was conducted in the sensitive areas in the Administrative Center of Manolo Fortich, particularly at Barangay Tankulan as shown in figure 1. The area is situated at the heart of the municipality wherein commercial establishments and government offices agglomerate within the area. There were five identified sensitive areas in the vicinity: Manolo Fortich Central Elementary School (MFCES), Manolo Fortich National High School (MFNHS), Manolo Fortich Christian Academy (MFCA), Northern Bukidnon State College (NBSC), and Municipal Health Center

Office. The research locale was selected since it is an emerging component City and there was no baseline data available for noise in the selected sensitive areas.

Figure 1

Location of the Sensitive Areas in the Administrative Center of Manolo Fortich



The noise quality data for each location was gathered was gathered from July 12 to August 2, 2023, through an SL-4010 sound level meter across three weeks (15 days) during morning and afternoon. Testing time for the morning data started at 09:00 AM and 03:00 PM for the afternoon data. The researchers sent a letter of permission to the Dean of the College of Engineering Graduate Studies to allow the conduct of the study. The researchers proceeded to the ethics board to secure an ethical clearance. The researchers made sure to observe and follow the ethical guidelines and formal approaches in the study area. The content of the study was subjected to a careful review by the adviser and reviewers of the Ethics Board. The screening was thoroughly carried out to guarantee the quality and dependability of the results and findings. Formal communication letter was also submitted to the Tankulan Barangay Council, addressed to the Chairman, to seek permission to conduct the data gathering on the study sites. After the approval of the Ethics Board, the researchers administered the data gathering of noise quality in the sensitive areas of the administrative center in Manolo Fortich, Bukidnon.

The recorded sound level was photographed and recorded in a Google sheet for statistical use in this research study. Furthermore, verification was done to make sure that

each value falls on the range of the device, minimum of 35 dB and maximum of 130 dB. Data was compiled and evaluated against WHO guidelines. The quantitative analysis using F-test was conducted through IBM Statistical Package for Social Science Statistics (SPSS) for Windows, Version 25.0 software.

4. Findings and Discussion

The noise level in the sensitive areas in Barangay Tankulan that captured during the three-week period is shown in table 1, also indicating the time of the day.

Table 1

Noise level in the sensitive areas of the Administrative Center in Manolo Fortich, Bukidnon

Sensitive Area	Week	Time	Noise Levels (dBA)	Remarks
Manolo Fortich National High School (MFNHS)	1	AM	73.93	Not Complied
	1	PM	72.46	Not Complied
	2	AM	70.88	Not Complied
	2	PM	73.05	Not Complied
	3	AM	73.61	Not Complied
	3	PM	73.76	Not Complied
Manolo Fortich Central Elementary School (MFCES)	1	AM	72.99	Not Complied
	1	PM	72.61	Not Complied
	2	AM	70.60	Not Complied
	2	PM	72.49	Not Complied
	3	AM	73.97	Not Complied
	3	PM	73.97	Not Complied
Manolo Fortich Christian Academy (MFCA)	1	AM	70.41	Not Complied
	1	PM	70.95	Not Complied
	2	AM	69.85	Not Complied
	2	PM	68.67	Not Complied
	3	AM	71.26	Not Complied
	3	PM	71.53	Not Complied
Manolo Fortich Municipal Health Center	1	AM	65.26	Not Complied
	1	PM	64.71	Not Complied
	2	AM	62.46	Not Complied
	2	PM	63.61	Not Complied
	3	AM	60.38	Not Complied
	3	PM	58.33	Not Complied
Northern Bukidnon State College (NBSC)	1	AM	60.49	Not Complied
	1	PM	57.85	Not Complied
	2	AM	57.41	Not Complied
	2	PM	53.06	Complied
	3	AM	57.20	Not Complied
	3	PM	55.47	Not Complied

To summarize the data captured daily in the morning and in the afternoon, the average of the noise levels was calculated. Among the noise levels captured, the peak was captured in the vicinity of the MFCES on the third week of the data gathering. The noise level was recorded at 73.97 dBA for both morning and afternoon, while the lowest recorded noise level was at NBSC during the second week of the data gathering, particularly in the afternoon at 53.06 dBA. The table shows that the majority of the noise levels recorded from the sensitive areas across three weeks are above the World Health Organization standard regulation of 55 dBA.

The United States Environmental Protection Agency (USEPA) also recommends that the day and night noise levels outside hospitals to protect the public welfare must not exceed 55 dBA (Montes-González et al., 2019). Only NBSC recorded the complied noise level during the afternoon of the second week at 53.06 dBA. This indicates that the people in the sensitive area around the Administrative Center of Tankulan, Manolo Fortich are exposed to an annoyance level of noise. The Manolo Fortich Municipal Health Center was not compliant with the standard noise level recommended by USEPA. The familiar sources of annoying noise are transportation-related noise, road traffic, people's chatter, and other human activities.

Table 2

Comparison of the environmental noise levels recorded between the sensitive areas in the Administrative Center Manolo Fortich, Bukidnon in the morning (AM)

Variables	Level of Significance	Mean Difference	P-value	Result
MFCES and MFNHS	0.05	-0.28	0.999	No significant Difference
MFCA and MFNHS	0.05	-2.30	0.349	No significant Difference
Health Center and MFNHS	0.05	-10.11	0.000	Has Significant Difference
NBSC and MFNHS	0.05	-14.44	0.000	Has Significant Difference
MFCA and MFCES	0.05	-2.02	0.488	No significant Difference
Health Center and MFCES	0.05	-9.82	0.000	Has Significant Difference
NBSC and MFCES	0.05	-14.16	0.000	Has Significant Difference
Health Center and MFCA	0.05	-7.81	0.000	Has Significant Difference
NBSC and MFCA	0.05	-12.14	0.000	Has Significant Difference
NBSC and Health Center	0.05	-4.33	0.006	Has Significant Difference

Legend: Manolo Fortich National High School (MFNHS); Manolo Fortich Central Elementary School (MFCES); Manolo Fortich Christian Academy (MFCA); Northern Bukidnon State College (NBSC)

The noise level comparison across the sensitive areas in Barangay Tankulan is shown in table 2. The p-value is less than the level of significance (0.05), which indicates that the observed differences are statistically significant in the morning. The NBSC and the Municipal Health Center demonstrated the lowest noise level, with a mean difference of -4.33 and a p-value of 0.006, below the 0.05 threshold. This result indicates a significant difference in noise levels between these two locations. Their lower noise levels are attributed to their location since they are both away from major roads and commercial areas. The results that show "No Significant Difference" are amongst MFCES, MFCA, and MFNHS. Noise annoyance often emanates from vehicular traffic and these three areas are closest to roads and may experience increased noise levels due to the movement of vehicles.

The key result that emerges from this research is explicit. The p-value is recorded as 0.0000, well below the chosen significance level (0.05). Moreover, the F-value of 72.05 reinforces the statistical significance of the findings. These results collectively affirm the rejection of the null hypothesis, which stated that there is no significant difference in noise levels across different sensitive areas in the Administrative Center of Tankulan during the morning. These variations may be attributed to the proximity of sensitive areas to noise sources. The significance of this difference highlights the importance of urban planning and zoning regulations. Understanding which areas are more prone to elevated noise levels can inform land use and infrastructure development decisions.

Table 3 shows the noise level comparison across the sensitive areas in Barangay Tankulan in the afternoon at a customary threshold of 0.05. This crucial benchmark guides the interpretation of statistical results. When the p-value falls below this threshold, it indicates that the observed differences in noise levels are statistically significant. It is evident from the results that the noise levels at NBSC and the Municipal Health Center are consistently lower compared to other locations in the study area. With both locations showing statistically significant mean differences in noise levels, it leads to considerable factors that these areas have a relatively quieter environment. Noise annoyance often emanates from vehicular traffic. Locations such as MFNHS, MFCES, and MFCA may experience increased noise levels due to the movement of vehicles during peak hours.

The p-value at 0.0000 is a resounding declaration of statistical significance. Moreover, the F-value of 84.93 adds further weight to the argument for significance. These results decisively reject the null hypothesis, suggesting no significant difference in noise

levels across different sensitive areas in the Administrative Center of Tankulan during the afternoon (PM). The afternoon hours have increased vehicular traffic, commercial activities, and community gatherings in specific areas. These activities contributed to elevated noise levels.

Table 3

Comparison of the environmental noise levels recorded across the Sensitive Areas in the Administrative Center of Tankulan, Manolo Fortich, Bukidnon in the afternoon (PM)

Variables	Level of Significance	Mean Difference	P-value	Result
MFCES and MFNHS	0.05	-0.25	1.000	No significant Difference
MFCA and MFNHS	0.05	-2.91	0.217	No significant Difference
Health Center and MFNHS	0.05	-11.08	0.000	Has Significant Difference
NBSC and MFNHS	0.05	-17.84	0.000	Has Significant Difference
MFCS and MFCES	0.05	-2.66	0.304	No significant Difference
Health Center and MFCES	0.05	-10.83	0.000	Has Significant Difference
NBSC and MFCES	0.05	-17.59	0.000	Has Significant Difference
Health Center and MFCA	0.05	-8.17	0.000	Has Significant Difference
NBSC and MFCA	0.05	-14.92	0.000	Has Significant Difference
NBSC and Health Center	0.05	-6.76	0.000	Has Significant Difference

Legend: Manolo Fortich National High School (MFNHS); Manolo Fortich Central Elementary School (MFCES); Manolo Fortich Christian Academy (MFCA); Northern Bukidnon State College (NBSC)

Table 4

Noise level across weeks at the Sensitive Areas in the Administrative Center of Tankulan, Manolo Fortich, Bukidnon in the afternoon in the morning (AM)

Sensitive Area	Level of Significance	P-value	F-value	Result
MFNHS	0.05	0.226	1.69	No Significant Difference
MFCES	0.05	0.196	1.90	No Significant Difference
MFCA	0.05	0.747	0.30	No Significant Difference
NBSC	0.05	0.220	1.72	No Significant Difference
Health Center	0.05	0.005	8.36	Has Significant Difference

Legend: Manolo Fortich National High School (MFNHS); Manolo Fortich Central Elementary School (MFCES); Manolo Fortich Christian Academy (MFCA); Northern Bukidnon State College (NBSC)

The p-value of 0.226 and an F-value of 1.69 are shown in table 4. These statistics affirm no significant difference in noise levels at MFNHS across the three weeks studied.

The daily activities and routines at MFNHS remain consistent weekly, resulting in a stable noise environment. The P-value of 0.196 is more than the alpha at 0.05 while the F-value is at 1.90, indicating the acceptance of the null hypothesis. This implies no significant difference in the noise levels across the weeks at MFCES in the morning. It is possible that the daily activities and routines at MFCES remain consistent from week to week, contributing to a stable noise environment during the morning hours. The P-value (0.747) is more than the alpha at 0.05 while the F-value is at 0.30, indicating the acceptance of the null hypothesis. It implies no significant difference in the noise levels across the weeks at MFCA in the morning. It seems conceivable that MFCA's morning routines and activities are consistent weekly, resulting in a consistent noise environment during these hours. The P-value (0.220) is more than the alpha at 0.05 while the F-value is at 1.72, indicating the acceptance of the null hypothesis. It implies that there is no significant difference in the noise levels across the weeks at NBSC in the morning. The morning routines and activities at NBSC may be consistent weekly, creating a steady noise environment throughout these hours. The P-value (0.005) is more than the alpha at 0.05 while the F-value is at 8.36, indicating to reject the null hypothesis. It implies that there is a significant difference in the noise levels across the weeks at Manolo Fortich Health Center in the morning.

Table 5

Post hoc analysis of noise levels at Manolo Fortich Health Center in the morning (AM)

Variables	Level of Significance	Mean Difference	P-value	Result
Week 2 and Week 1	0.05	-2.80	0.105	No Significant Difference
Week 3 and Week 1	0.05	-4.88	0.005	Has Significant Difference
Week 3 and Week 2	0.05	-2.08	0.260	No Significant Difference

Table 5 shows the morning routines and activities at the Health Center may exhibit variations from week to week, leading to fluctuations in the noise environment during these hours. Moreover, the discrepancies observed may be due to external events, such as construction, and increased traffic during the day since people going to the health center often ride motor vehicles that contribute to the noise in the area.

Table 6

Noise level across weeks at the Sensitive Areas in the Administrative Center of Tankulan, Manolo Fortich, Bukidnon in the afternoon in the afternoon (PM)

Sensitive Area	Level of Significance	P-value	F-value	Result
MFNHS	0.05	0.725	0.33	No Significant Difference
MFCES	0.05	0.633	0.48	No Significant Difference
MFCA	0.05	0.131	2.42	No Significant Difference
NBSC	0.05	0.251	1.55	No Significant Difference
Health Center	0.05	0.006	8.24	Has Significant Difference

Legend: Manolo Fortich National High School (MFNHS); Manolo Fortich Central Elementary School (MFCES); Manolo Fortich Christian Academy (MFCA); Northern Bukidnon State College (NBSC)

Table 6 shows a remarkable p-value of 0.725 and an F-value of 0.33. These statistics clearly assert that there is no significant difference in noise levels at MFNHS across the three weeks examined during the afternoon (PM). Mainly because the routine activities and dynamics within MFNHS remain relatively stable during the afternoon hours across different weeks, resulting in a consistent noise environment. The P-value (0.633) is more than the alpha at 0.05 while the F-value is at 0.48, indicating the acceptance of the null hypothesis. It implies that there is no significant difference in the noise levels across the weeks at MFCES in the afternoon. It is conceivable that the weekly variations in the afternoon routines and activities at MFCES result in a predictable level of noise during these hours. The P-value (0.131) is more than the alpha at 0.05 while the F-value is at 2.42, indicating the acceptance of the null hypothesis. It implies no significant difference in the noise levels across the weeks at MFCA in the afternoon. It is plausible that the afternoon activities and routines at MFCA remain relatively uniform from week to week, resulting in a stable noise environment during these hours. The P-value (0.251) is more than the alpha at 0.05 while the F-value is at 1.55, indicating the acceptance of the null hypothesis. It implies that there is no significant difference in the noise levels across the weeks at NBSC in the afternoon. The morning routines and activities at NBSC are largely consistent from week to week, leading to a consistent noise environment throughout these hours. The P-value (0.006) is more than the alpha at 0.05 while the F-value is at 8.24, indicating to reject the null hypothesis. These affirm that there is a significant difference in noise levels at the Health Center across the three weeks observed during the afternoon hours.

Table 7

Post hoc analysis of noise levels at Manolo Fortich Health Center in the afternoon (PM)

Variables	Level of Significance	Mean Difference	P-value	Result
Week 2 and Week 1	0.05	-1.09	0.813	No Significant Difference
Week 3 and Week 1	0.05	-6.38	0.009	Has Significant Difference
Week 3 and Week 2	0.05	-5.29	0.027	Has Significant Difference

Table 7 shows the afternoon activities at the Health Center may exhibit dynamic variations from week to week. The P-value 0.009 and 0.027 is more than the alpha at 0.05 indicating that there is a significant difference in noise levels at the Health Center across the three weeks observed during the afternoon hours. This leads to fluctuations in the noise environment during these hours, primarily because of its location near the municipal procurement office wherein people delivering and getting stocks at the warehouse may contribute to the noise.

5. Conclusion

The noise data collected in the sensitive areas of the Administrative Center in Barangay Tankulan, Manolo Fortich, Bukidnon revealed that across the weeks, MFNHS, MFCES, MFCA, and NBSC were higher than the recommended level by the World Health Organization and the United States Environmental Protection Agency (USEPA), which is 55 dBA. However, NBSC recorded a complied remark on its second-week afternoon data. This result indicates the occurrence of noise pollution in the sensitive areas. This further indicates that people are exposed to environmental noise at an annoyance level, which may hamper learning and focus on daily activities. There is a significant difference in the noise levels across the sensitive areas in both morning and afternoon. The study revealed that for MFNHS, MFCES, MFCA, and NBSC, there were no significant differences in the noise level found across the weeks of data gathering for both morning and afternoon. At the same time, there is a significant difference in the noise level at the Manolo Fortich Municipal Health Center across the weeks for both morning and afternoon.

The study area is within the sensitive areas found in the Administrative Center of Brgy. Tankulan, Manolo Fortich, Bukidnon. The noise level for the schools along the highway was higher than that of the tertiary institution located farther from the national

highway. This study has substantial significance for both the local community and broader environmental concerns. Moreover, the result of this study serves as baseline information for the local government unit of Manolo Fortich to address issues concerning noise pollution, improve program implementation, and create policies to help the people exposed in the sensitive areas to have a healthier environment and protect themselves from noise annoyance or health issues related to noise pollution exposure.

Addressing the growing concerns about noise annoyance in the sensitive areas of the Administrative Center of Manolo Fortich, Bukidnon is a critical endeavor that requires unselfish strategies and concerted efforts. To pave the way for a quieter and more peaceful environment, the following research recommendations are offered:

Noise monitoring, evaluation, and impact assessment. Establish a continuous monitoring system to track noise levels over time. Regularly evaluate the effectiveness of noise reduction measures and adjust strategies as needed (Alsina-Pagès et al., 2019). Conduct a comprehensive noise impact assessment across the sensitive areas within the Administrative Center. This assessment should include detailed measurements of noise levels, identification of crucial noise sources, and an evaluation of the impact on the well-being of residents and workers (Khaiwal et al., 2016).

Urban planning and zoning regulations. Collaborate with urban planners and policymakers to review and update zoning regulations. Implement strict zoning codes that segregate noise-intensive activities from residential and sensitive areas. This can help prevent the encroachment of noise sources into quiet zones (Tong, 2022). Collaborate with legislators to develop and pass laws and policies that prioritize noise reduction and acoustic well-being. Enact and rigorously enforce noise ordinances stipulating permissible noise levels and quiet hours. Ensure that fines and penalties for noise violations are effectively enforced. These may include stricter regulations for vehicle noise, restricted hours for construction activities, and the use of noise-reducing technologies (Gilani & Mir, 2021). Collaborate with transportation authorities to optimize traffic flow and reduce peak-hour congestion.

Noise barriers and buffer zones. Design and install noise barriers, such as sound walls or vegetation, between noise sources like highways and commercial zones in sensitive areas. Create buffer zones with vegetation to absorb and dissipate noise. This can be achieved by planting more trees around the sensitive areas (Ow & Ghosh, 2017). Incorporate green spaces

and acoustic design principles into urban planning. Parks and green areas not only enhance the aesthetics of the area but also provide natural sound buffers.

Public awareness and education collaboration: Launch public awareness campaigns to educate residents and businesses about the adverse effects of noise pollution and the importance of noise reduction. Encourage individuals and organizations to adopt noise-conscious practices (Bala & Verma, 2020). Involve the local community in noise reduction initiatives. Establish noise-monitoring committees composed of residents, businesses, and experts to ensure continuous monitoring and implementation of noise control measures. Collaborate with educational institutions, such as Northern Bukidnon State College, to research noise pollution and its effects. Engage students and faculty in developing noise reduction solutions.

Descriptive-correlational research. Simultaneously conduct tests to gauge the cognitive ability of the students, teachers, and workers who are within the vicinity of the testing area. Descriptive and inferential statistics can be used to determine a connection between the comprehension of students, as well as the cognition of teachers and other employees (Diaco, 2014; Ellen et al., 2021).

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